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how to control SOIL BLOWING

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HOW TO CONTROL SOIL BLOWING

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Depletion of vegetative cover on the land is the basic cause of soil erosion by wind or water. Little erosion occurs under natural conditions. Restoring the vegetative cover comparable to natural conditions would appear to be the logical solution for erosion control. However, man must till the soil to produce crops, graze the land to produce livestock, and cut trees to supply other needs. All these practices tend to deplete the vegetative cover on the land.

The most serious damage from wind-blown soil particles in some regions is the sorting of soil material. Wind erosion gradually removes silt, clay, and organic matter from the surface soils. The remaining materials may be sandy and are infertile; the sand often piles up in dunes and presents a serious threat to better surrounding lands. As recorded in history, huge agricultural areas in different parts of the world have been seriously damaged in this manner.

Soil blowing causes other damage. Crops are often destroyed by abrasion of wind-blown soil particles. Insects and weed seeds are blown far and wide with drifted soil, to infest clean fields. Mounds of accumulated soil may smother grass, shrubs, and trees. Drifting soil often buries and ruins fences, hedges, and shelterbelts. Drifted soil sometimes blocks entrances to farmsteads and makes the buildings unsuitable for living quarters.

During duststorms, traffic is sometimes held up on roads and traffic accidents are common. Duststorms are disagreeable and sometimes unbearable to farmers and their families. Farm animals suffer and sometimes die from dust suffocation. People in villages, towns, and cities also suffer some inconveniences from duststorms.

Consequently, in areas susceptible to soil blowing, great care is required to raise crops and livestock and to conserve the soil.

PRIMARY CAUSES AND REMEDIES OF SOIL BLOWING

Soil erosion is caused by a *strong wind* blowing in the *direction* that gives the greatest distance across a *large* and *unprotected* field with a *smooth* and *bare* surface and a *loose, dry*, and *finely granulated* soil.

Conversely, nine general ways can reduce or eliminate soil blowing: Keep the soil *firm* and *moist*; create soil aggregates or clods *large* and *stable* enough so they cannot be moved or abraded by wind; *roughen* the surface to trap and protect the fine soil particles; *cover* with and preferably maintain vegetation or

[1] The information reported in this bulletin was made possible by research conducted in cooperation with the Kansas Agricultural Experiment Station.

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vegetative residue on the land; *narrow* the width of fields and arrange the broad sides of the fields at *right angles* to the prevailing direction of wind; and reduce the velocity of wind near the ground by using *barriers* placed along the path of the wind.

SOIL AND SOIL BLOWING PROCESSES THAT AFFECT CONTROL MEASURES

Rain, compaction by implements and livestock, and soil micro-organisms tend to cement eroded soil particles together into larger, nonerodible aggregates. On the other hand, repeated wetting and drying, and especially freezing and thawing of the soil, tend to soften and disintegrate the surface crust and aggregates and to increase soil blowing. Because of these two counteracting processes, maximum degree of soil consolidation and aggregation occurs usually below a depth of 3 to 4 inches.

Bringing clods to the surface controls wind erosion temporarily, because clods at the surface readily weather down to erodible particles. For a permanent method of wind erosion control, the soil surface must be covered by living plants or by dead vegetation continuously replenished.

Decomposing vegetative matter produces cementing materials that bind the soil particles together to form water-stable soil aggregates large enough to resist wind erosion. On the other hand, decomposed organic matter—that is, the products of decomposition that normally give the soil a black color—produces fine soil granules that increase wind erosion. As a result, a mulch should be added to the soil to maintain sufficient vegetative matter above the surface to protect the soil from wind erosion. Thus, vegetative cover, and not organic matter in the soil, is needed to control soil blowing.

Soil blowing begins when the most erodible particles range in size from very fine to medium sand. These sizes are moved by wind in jumps known as *saltation*. The jumping particles cause fine dust to be blown far through the atmosphere. The saltating particles also cause the coarser grains to roll and slide along the surface of the ground. Farmers should not allow the soil to become finely granulated —a condition most susceptible to movement by saltation.

The impacts of grains in saltation tend to break up the surface crust and clods into fine fragments that, in turn, are moved by the wind. This breakup is called *abrasion*. The sandier the soil, the more susceptible it is to abrasion.

The rate of soil flow is zero at the windward edge of an eroding field, but the rate increases with distance to leeward until it reaches the maximum that a given wind can carry. The increase in soil flow with the distance downwind is called *soil avalanching*. The larger the proportion of erodible fractions in the soil and the more the surface crust and clods are susceptible to abrasion from jumping particles, the greater is the rate of soil avalanching. For these soils, the fields should be narrow enough to slow the rate of soil movement to a tolerable limit.

The finer soil fractions are moved by wind faster than the coarser ones. This causes *sorting* of the soil materials. Fine dust, including much of the organic matter, is moved far and wide. Particles moved in saltation usually form dunes or drifts, whereas the coarser particles that roll along the surface form gravels and sands.

CONTROL MEASURES

Permanent methods include those soil conservation practices that will ordinarily control soil blowing for years. These practices include stubble mulching, cover crops, stripcropping, and crop rotations; proper choice and use of tillage, planting, and harvesting implements; wind barriers, shelterbelts, and regrassing and reforestation. Farmers may need to adopt all these permanent wind erosion practices, but sometimes they may have to fall back on emergency methods when a period of severe climatic conditions may cause poor crops.

Emergency methods include tillage to bring clods to the surface, furrowing, and placement of temporary barriers at intervals across the field. The term "preventive methods" describe these methods better, but "emergency methods" is so well-rooted in present-day vocabulary, it is used here.

STUBBLE MULCHING

Stubble mulching—the practice of maintaining crop residues at the ground surface—offers good protection from soil blowing. The degree of protection depends on the quantity and quality of the residue and planting and cropping practices used with stubble mulching.

It is impossible to estimate the quantity of crop residue required to control soil blowing unless all the major factors that affect soil blowing are known. For instance, the more susceptible the soil is to movement by wind, the more residue is required to prevent blowing. Large block fields require more residue than narrow fields or fields protected by windbreaks and shelterbelts. Arid areas need more residue than humid areas, and areas of high winds require more cover than those of low winds.

Pound for pound, fine residue gives more protection to the soil than coarse material, if the fine residue is equally distributed and anchored. Residue in a vertical position shelters the soil better than that in a leaning position and much better than residue in a flattened position. Long or tall-crop residue is more effective than short residue.

To reduce soil loss to an insignificant quantity for large open fields in the average semiarid region during the windy season—which usually is in the spring:

- ♦ A silt loam soil with 25 percent nonerodible fractions needs 750 pounds of 12-inch high standing and uniformly distributed wheat stubble or 1,500 pounds of 12-inch flattened wheat stubble per acre.
- ♦ A loamy sand with 25 percent nonerodible fractions needs 1,750 pounds of the standing stubble or 3,500 pounds of flattened wheat stubble per acre.
- ♦ If sorghum is substituted for wheat in the above examples, double the quantity of sorghum stubble.

To provide the quantity of stubble needed above, much more stubble should be left on the field after harvest. Some residue decomposes during the fall and winter.

Crops on extremely erodible sandy lands seldom supply enough cover to prevent soil blowing. Some farmers have found that the best remedy is to return such lands to permanent grass, shrubs, or trees, despite possible immediate lower income.

COVER CROPS

Although not planted specifically as a cover crop, winter wheat planted in late summer or early fall gives excellent to fair protection during the critical wind erosion period the following spring. The combination of a good stubble mulch from the preceding crop and of fall growth made by the wheat effectively controls soil blowing. If

PN-1109

Winter wheat planted with semideep furrow drill in rows 12 inches apart gives an effective cover crop. It provided about 700 pounds per acre of dry matter above the surface. Although this sandy loam soil is highly susceptible to wind erosion, little soil removal took place under an exceedingly dry and windy spring.

the wheat fails to germinate or to make sufficient cover in the fall, severe blowing may occur unless the land is protected with residue from a previous crop. If there is not enough crop residue at planting time, roughening the land and making it as cloddy as possible are temporary expedients against soil blowing. A semideep furrow drill is usually effective in establishing a rough surface until the wheat covers the ground.

If moisture is sufficient, some farmers plant cover crops of spring wheat, oats, or barley on summer fallow in late summer to prevent soil blowing. If the cover crop makes sufficient growth, it can be pastured. This system, used effectively in some northern areas, protects the soil during the following spring period of high winds before a spring crop is planted. Moisture used by these cover crops is often replaced by snow trapped by the vegetation.

In severe cases of soil blowing in the Great Plains, planting sorghum in summer provides a protective cover for the critical spring erosion period. This crop is often left unharvested.

STRIPCROPPING

For wind erosion control, crop strips are straight and run as nearly as possible at right angles to the prevailing winds; for water erosion control, crop strips follow as much as possible the contour of the land. The relative severity of the two types of erosion determines which system to use. However, to control

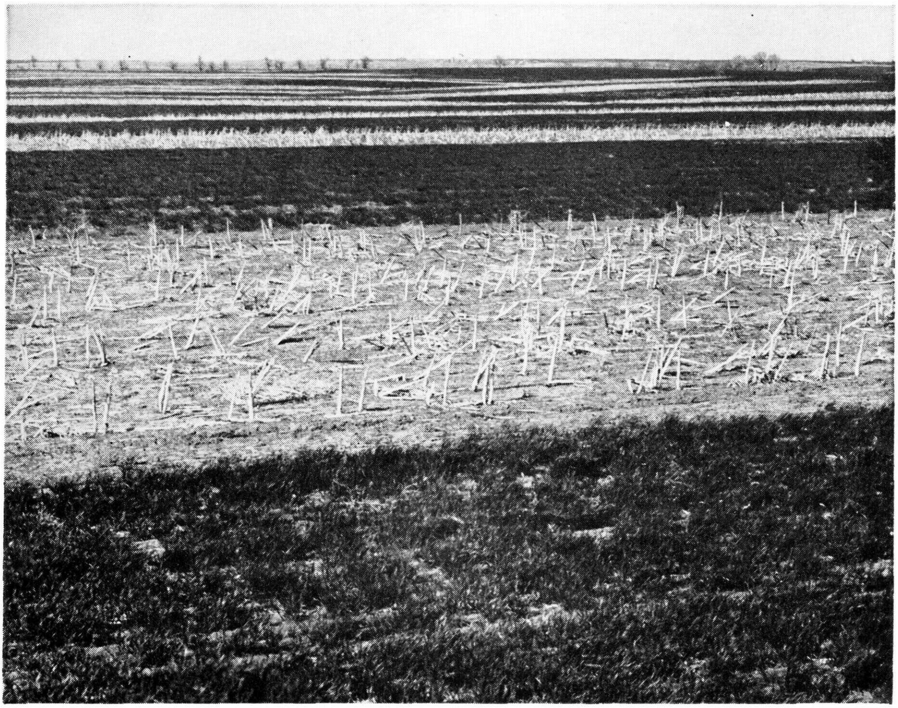
soil blowing, even contour stripcropping is better than large block farming.

Stripcropping does not require any change in cropping practices, nor does it remove any land from cultivation. The field is subdivided into alternate strips of erosion-resistant crops and erosion-susceptible crops or fallow. Stripcropping requires adequate quantities of crop residues as an additional protection against wind erosion.

Erosion-resistant crops are small grains and other crops seeded closely that cover the ground rapidly. Erosion-susceptible crops are cotton, tobacco, sugar beets, peas, beans, potatoes, peanuts, asparagus, and most truck crops. Corn and sorghum are intermediate in their resistance to wind erosion.

Stripcropping controls soil blowing by reducing soil avalanching, which increases with width of the eroding field. The rate of soil avalanching varies directly with the erodibility tendency of the soil. Therefore, the width of the strips is determined by the kind of soil in the field. For instance, in western Kansas strips with a 1-foot high stubble of erosion-resistant crops on their windward sides should have the following average width of crop strips for—

Soil:	*Width of strips (feet)*
Sand	20
Loamy sand	25
Granulated clay	80
Sandy loam	100
Silty clay	150
Loam	250
Silt loam	280
Clay loam	350
Silty clay loam	430



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Wheat and sorghum strips, 254 feet wide, are rotated with 254-foot strips of sorghum and fallow, then with wheat and fallow on this loam soil. Proper residue management has given adequate protection from wind erosion on this farm.

The width of the strip would be either narrower or wider in areas where wind velocity is higher or lower than that of western Kansas in spring.

Such topographic features as irregularity, length, degree, and exposure of slope in relation to prevailing winds influence the effectiveness of crop strips. These features and the soil type determine the design for a stripcropping system. Standard farm machinery does not work efficiently on strips narrower than about 50 feet. On those fields that require strips narrower than 50 feet, consider growing erosion-resistant crops continuously or seeding the field to a permanent cover.

CROP ROTATIONS AND FALLOWING

Most farmers in dryland areas subject to soil blowing follow rotations of wheat and fallow, wheat-wheat-fallow, and wheat-sorghum-fallow. These rotations are readily adapted to stripcropping. Other rotations that are longer and include grasses and legumes also work well in a stripcropping system.

The greatest damage from soil blowing is on fallow. However, in regions of low rainfall, fallow is essential to store moisture in the soil for the next crop. Fallow may not increase total crop yields.

On some lands that are susceptible to soil blowing, a continuous system of cropping has been substituted for fallowing. Continuous cropping increases the hazard of crop failure, but a growing crop each year assures a more continuous cover and reduces erosion.

MACHINERY TO CONTROL SOIL BLOWING

Tillage machinery and tillage practices can either aggravate or alleviate the soil blowing problem. Machines that tend to pulverize the soil or to diminish the vegetative cover increase soil blowing. If crops are grown, however, weeds and vegetative cover must be destroyed. Nevertheless, at the time the growing cover is destroyed, machines can create a cloddy and rough surface to prevent blowing.

Farmers should choose implements suited to conditions of a specific area and use them properly. They can choose tillage machinery that (1) turns a layer of soil over; (2) mixes or stirs the surface soil; or (3) cuts underneath the surface but neither mixes nor turns the soil layer.

Implements That Turn the Soil Over—*Moldboard* and *disk plows* are limited to humid and subhumid areas and to irrigated and special-problem soils. Plowing buries crop residues needed to control erosion. It is also a relatively expensive operation.

In some wind erosion areas, however, plows are used to turn under green manures, to produce a cloddy surface on soils denuded of residues, to kill certain types of weeds, or to bring up clayey materials on soils that have been sorted by wind.

Implements That Mix the Soil—The *lister* is a combination of furrow opener and planter. It provides good protection against soil blowing because it leaves the land ridged and rough. In dryland areas the lister is used for planting sorghum, for contour tillage to conserve soil moisture, to channel irrigation water to crops, or as an emergency tillage tool to control soil blowing.

The *single*, *offset*, or *tandem disk harrows* tend to chop and partly bury the residue and pulverize and loosen the soil. These implements smooth the surface, break up large clods on plowed land, and destroy weeds if not too large. Do not use disk harrows to cultivate smooth,

PN–1111

A 14-inch lister did a good job of ridging and throwing up clods here to resist wind erosion.

bare soils where soil blowing is a hazard.

Where soil blowing is a hazard, the *spring-tooth harrow* is somewhat better than the *spike-tooth harrow*. The spring-tooth harrow penetrates deeper, brings some clods to the surface, causes some ridging, and is more able to destroy small weeds than the spike-tooth harrow. Neither implement can operate in heavy residues. As a rule, use other implements in areas subject to soil blowing.

The *duckfoot cultivator* cultivates fallow, prepares the seedbed, and, to a limited extent, roughens and brings clods to the surface to stop soil blowing. This implement destroys weeds effectively if the residues are not too heavy to prohibit close spacing of the shovel shanks.

Chisel-type tools, available in a variety of designs, break up hard soil to permit better intake of rainfall. If the chisels penetrate deep enough to bring up compacted clods and to roughen the surface, these implements will control soil blowing. Chisels do not destroy weeds effectively.

The *one-way disk* is an excellent implement for working in heavy residues and for destroying weeds. The first disking maintains approximately 50 percent of the residue on the surface. The one-way disk buries too much residue and leaves the soil susceptible to blowing if residues are meager. Many farmers use the one-way disk only for heavy residues and for the initial tillage of stubbleland.

Rotary hoes and *skew treaders* spread bunched residue and pack the soil to form better seedbeds.

PN–1112

After harvest the heavy wheat stubble in this field was one-way disked to destroy weeds and put soil in condition to absorb moisture. Sufficient residue is left on the surface to protect the soil from wind erosion.

These implements tend to pulverize the soil regardless of residue quantity.

Implements That Cut Below the Surface—*Subsurface tillage implements* undercut land with a minimum disturbance of surface residues. They may maintain 80 to 90 percent of the residue on the surface after a single operation. However, these implements do not bring many clods to the surface to prevent soil blowing.

Subsurface tillage implements are equipped with either straight or **V**-shaped blades or rods. The **V**-blades are more extensively used and are 1 to 7 feet wide. Blade implements differ from the duckfoot cultivator in that the blades are wider and the shanks are fewer and longer for better clearance of residue.

Rod weeders destroy weeds, create a good seedbed, and maintain residues on top. On some rod weeders narrow duckfoot shovels or chisels are placed ahead of the rod. This added equipment undercuts hard ground.

Planting Machinery—To prevent soil blowing, use special planters to maintain land with a rough, cloddy, and residue-covered surface. Deep-furrow disk and shovels drills, with 12- to 14-inch spacing, are capable of going through heavy residues without clogging. Moreover, they place the seed at a depth where moisture is sufficient to permit germination. Use single- and double-disk drills only where residues are light.

PN—1113

For stubble mulching, this rod weeder with small duckfoot sweeps in front of the rod left 80 percent of the wheat stubble, mostly standing above the surface.

SOIL BLOWING AND WEED CONTROL

Improper or frequent cultivation to kill weeds and the volunteer crop increases the hazard from soil blowing. However, to conserve soil moisture and maintain crop yields, choose a time and use an implement that will destroy all existing growth, preferably in one operation. At the same time, leave the soil surface rough and leave some residue to prevent soil blowing. The soil condition and the amount and kind of crop residue determine the type of implement to use.

Some weed growth may control soil blowing. Little moisture is lost if the weeds are not more than 2 or 3 inches high before they are destroyed by tillage. If the season is inducive to soil blowing or the soil is highly erodible, delay tillage until planting time or until conditions are more favorable for erosion control.

In some areas annual weeds are killed by frost. If the land is not seeded in the fall, kill the perennial weeds in the spring rather than in fall.

Where grasses and legumes are grown successfully in crop rotations, both weeds and soil blowing are much easier to control.

SOIL BLOWING AND INSECT CONTROL

Insects and mites—such as the hessian fly, greenbugs, aphids and curl mites that carry wheat streak mosaic — maintain themselves chiefly on volunteer wheat from harvest until the next wheat crop

is planted in the fall. Destroying the volunteer wheat with implements that leave the residues on the surface will control these insects and will prevent soil blowing as well.

Some insects that feed primarily on wheat will not attack other crops. Planting wheat in rotation with other crops or with fallow will reduce infestations of hessian fly, wheat strawworm, wheat white grub, and wheat stem sawfly. To control soil blowing, stripcrop with crops resistant to wheat insects where fallow is necessary.

Stripcropping presents difficulties in controlling lesser migratory grasshoppers (*Melanoplus mexicanus*) in winter wheat regions. The grasshoppers move from stubble strips into edges of wheat strips in the fall and consume the young plants. Spray margins of stubble strips and roadsides with aldrin, chlordane, heptachlor, or toxaphene before the new wheat is up. If heavy grasshopper outbreaks are impending, substitute sorghum or other spring crops for winter wheat. In late fall or early spring, fallow strips can be listed to prevent any soil blowing that might occur.

Wheat curl mites that transmit wheat streak mosaic and greenbugs may infest early plantings of winter wheat. Do not plant wheat early when the mosaic was prevalent the previous year. Delayed seedings, however, may cause serious soil blowing where residue cover is inadequate. Under such conditions, adopt stripcropping as a permanent measure.

WINDBREAKS, SHELTERBELTS, AND OTHER BARRIERS

Any barrier, such as soil ridge, stubble crop, hedge, or tree windbreak or shelterbelt, in rows and at intervals at right angles to the direction of the prevailing wind, reduces the surface wind velocity and soil blowing. In many areas barriers not only control soil blowing but also trap snow and reduce evaporation and transpiration.

PN–1114

A shelterbelt traps snow and protects the soil from wind for some distance away from the belt. It is indispensable to farm homes.

The effectiveness of any barrier depends on such factors as wind velocity and direction and on barrier shape, width, and porosity. When the wind blows at right angles to an average tree shelterbelt, wind velocity is reduced 70 to 80 percent near the belt. At a distance equal to 20 times the height of the belt, the velocity is reduced by 20 percent, and at a distance equal to 30 to 40 belt-heights leeward of the belt, no reduction in velocity occurs. The higher the average wind velocity, the closer the belts or other barriers should be spaced to protect the soil from blowing. If the wind velocity is 40 miles per hour at a 50-foot height and the barrier is 25 feet high, space the barriers 250 feet apart, or 10 times the height of the barrier—to protect bare and extremely erodible sandy soils. For less erodible soils with some crop residue and for lower wind velocity, space barriers farther apart.

EMERGENCY TILLAGE

If vegetative cover becomes depleted, emergency tillage will be necessary. Emergency tillage should be used as a last resort, after such methods as stubble mulching, cover crops, stripcropping, crop rotations, regular tillage practices, and windbreaks and other barriers have failed. The purpose of emergency tillage is to create a rough, cloddy soil surface that will resist the force of the wind. This measure is only temporary, as clods readily disintegrate.

Use emergency tillage before soil blowing starts rather than after. Soil becomes rapidly more erodible under abrasion of moving soil particles and requires more drastic measures to prevent it from further erosion.

Measures for Soil Types—Sandy soils are by far the most difficult to hold with emergency tillage. Few clods are obtained, no matter what the depth or what tool is used. At best, any emergency measure in sand will be rather short-lived; it is far better to keep such soils permanently covered with vegetation. If, however, tillage is required, work the entire area with a lister at sufficient depth to produce a rough surface. As soon as possible, farmers should allow a vegetative cover provided by nature to take over rather than continue to till and keep the surface rough. There is more danger of erosion from too much tillage of sandy soils than with no tillage.

Fine- and medium-textured soils respond more readily to emergency tillage than the sands. Use chisels to produce a rough, cloddy surface, and chisel the whole field rather than at intervals across the field.

Tillage Practices—Listers with either 8- or 14-inch bottoms, narrow and heavy-duty chisels, and duckfoot and wide-spade shovel culti-

PN-1115

A chisel-point cultivator (chisel) does a good job of bringing clods to the surface on fine-textured, compacted soils. The chisel is not effective on loose sandy soils.

vators are effective implements for emergency tillage. The seriousness of the possible erosion hazard, soil texture, and cropping system determine the choice of implement and the method to use.

Emergency tillage must be at right angles to the prevailing winds. Till deep enough to bring compact clods to the surface—usually 3 to 6 inches. If soil blowing is expected to be serious, till not only on individual fields but large areas. Use a 14-inch lister with 42-inch spacing or an 8-inch lister spaced 20 to 24 inches. If soil blowing is expected to be moderate, tillage of individual fields with chisels or cultivators will be sufficient. For most types of chisels, a 24-inch spacing provides good protection. Intermediate speeds of cultivation—3.5 to 4.0 miles per hour—provide the most effective surfaces.

A crop also determines the choice of emergency tillage methods. Often a wheat crop may be too sparse to hold against erosive winds, yet a partial crop may be salvaged. In these cases, till the entire field with a chisel with the points spaced 54-inches apart.

RECLAIMING DRIFTING SANDS AND SAND DUNES

Drifting sands and sand dunes are much more difficult to stabilize than cultivated soils and constitute a special reclamation problem. These areas are usually very rough and hummocky. Leveling sand dunes prior to reclaiming the land usually increases the difficulty of stabilizing the sand.

Dune sands are easiest to reclaim during periods when rainfall is most plentiful and wind velocity is lowest. Smooth out only the crests of the dunes with a dragpole or a bulldozer. Work the side of the field facing the prevailing direction of the wind first. To bring some clods to the surface use a deep-furrow cultivator where sand accumulation is shallow; use a lister for deeper sand accumulations. As a temporary cover, seed this stabilized land to broomcorn, sudangrass, or a small-grain crop such as rye.

On very deep sand accumulations, use mulches of straw, hay, brush, or other vegetative materials to anchor the sand. Add the mulch on the windward side first. Apply the mulch uniformly with a blower-type spreader or a converted manure spreader. Spread at least 1½ to 2 tons per acre of prairie hay or wheat straw or 3 to 4 tons of corn or sorghum fodder. To anchor the mulch, use a colter-type packer.

Plant suitable grasses, shrubs, or trees for permanent stabilization of temporarily reclaimed areas. The final objective is the establishment of native vegetation. Drill grass seed directly in the temporary cover or mulch. Broadcast the seed on rough land, even though the task may be tedious. At the time of seeding the grass, be sure that the temporary cover of weeds, whole plants, or stubble is dead, so that it will not compete with the grass seedlings for moisture.

Manage stabilized sand-dune land carefully. Cover trails and roads leading through loose sand with nonerodible material such as gravel. Do not build homes on sand. Guard grasslands, woodlands, or scrublands from fire, overgrazing, or excessive cutting of trees. Use stabilized dunes mostly for recreational purposes and limited pasture or woodland.

Local offices of the Soil Conservation Service, the Extension Service, State experiment station, or other agency can supply information on the most suitable grasses, shrubs, or trees for reclaiming sand dunes in the area.

COMMUNITY EFFORT AND LEGISLATION

Although individual efforts are usually very effective in controlling soil blowing, the most successful results are obtained where groups of farmers promote community action against the problem. Soil blowing on one uncontrolled area can often spread to carefully managed farms and ruin them. Community action is often aided by State and Federal laws. Also, community laws often place the responsibility for soil-blowing damage done to neighbors' properties upon the owners of the land where the soil blowing originated, unless these owners have used control measures as prescribed by law.

TO CONTROL SOIL BLOWING—

- Keep a crop or stubble on land as much as possible.
- Stripcrop on soils that permit strips.
- Plant row crops at right angles to prevailing winds.
- Maintain high soil productivity with fertilizers and rotations.
- Use tillage machines that provide a rough and cloddy surface.
- Plant a permanent cover of native vegetation on sands and extremely erodible soils.
- Use emergency tillage before blowing starts if the methods above appear to have failed.
- Work together in the community to control wind erosion.

Growth Through Agricultural Progress

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